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10/532,236	04/22/2005	Andrew Jonathan Tuberfield	GRT/117-540	9069

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ARLINGTON, VA 22203

EXAMINER

VERDERAME, ANNA L

ART UNIT	PAPER NUMBER
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1795

MAIL DATE	DELIVERY MODE
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12/21/2007

PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary

Application No.

10/532,236

Applicant(s)

TUBERFIELD ET AL.

Examiner

Anna L. Verderame

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 22 April 2005.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-24 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-24 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 22 April 2005 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All b) ☐ Some * c) ☐ None of:
- ☐ Certified copies of the priority documents have been received.
 - ☐ Certified copies of the priority documents have been received in Application No. _____.
 - ☒ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☒ Information Disclosure Statement(s) (PTO/SB/08)
- Paper No(s)/Mail Date 12/13/05, 04/22/05.

- 4) ☐ Interview Summary (PTO-413)
- Paper No(s)/Mail Date. _____
- 5) ☐ Notice of Informal Patent Application
- 6) ☐ Other: _____

DETAILED ACTION

Claim Rejections - 35 USC § 112

1. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

2. Claims 23-24 rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. Claim 23 and 24 recite a "material having selected optical properties". This claim is indefinite because it is unclear what optical properties the applicant intends.

3. Claim 23 provides for the use of "a structure formed in accordance with the method of claim 21 as a template to define the optical element in a material of selected optical properties", but, since the claim does not set forth any steps involved in the method/process, it is unclear what method/process applicant is intending to encompass. A claim is indefinite where it merely recites a use without any active, positive steps delimiting how this use is actually practiced.

Claim 23 is rejected under 35 U.S.C. 101 because the claimed recitation of a use, without setting forth any steps involved in the process, results in an improper definition of a process, i.e., results in a claim which is not a proper process claim under 35 U.S.C. 101. See for example *Ex parte Dunki*, 153 USPQ 678 (Bd.App. 1967) and *Clinical Products, Ltd. v. Brenner*, 255 F. Supp. 131, 149 USPQ 475 (D.D.C. 1966).

Claim Rejections - 35 USC § 102

4. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this

Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

5. Claims 1, 3-4, 16-17, 21-22 are rejected under 35 U.S.C. 102(b) as being anticipated by Sakai et al. 6,331,383.

Sakai et al. teaches a method for manufacturing a semiconductor device comprising a method for patterning comprising exposing a step of forming a photosensitive film by applying a photosensitive composition in which the transmittance of light out of the range of the exposing wavelength decreases by exposure, a step for exposing a predetermined portion of the film to a light of a first wavelength to decrease the transmittance of light of a second wavelength region at the surface layer of the predetermined portion of the photosensitive film, a step for exposing the resist film to light of a second wavelength by using the surface layer of the predetermined portion as a mask, and a step for developing the photosensitive film(2/32-45). In example 1 a resist is coated on a substrate and exposed to KrF laser at predetermined regions. The exposure causes a reaction between a photo-acid generator and a pH sensitive dye which result in decreased transmittance to the i-line at the surface

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layer in the exposed areas. These opaque areas are used as a mask to expose the un-exposed region of the photo-resist using the i-line.

Claim Rejections - 35 USC § 103

6. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

7. Claims 1,3-5,15-17, and 20 are rejected under 35 U.S.C. 103(a) as being unpatentable over Neckers 5,942,370 in view of Nagashima et al. 4,258,123 and Caruso 5,407,783.

Neckers teaches a method for producing a **three dimensional object** comprising the steps of (a). providing a film of a photo-hardenable composition and a photo-responsive agent,(b) radiating the film to form a pattern,(c) selectively radiating one or more portions of the thus formed pattern which are desired to be colored differently, and (d) repeating steps a-c to produce the desired pattern(claim 20)(abstract). The reference further teaches a color-determinative or tactile characteristic determinative radiation step conducted after the first exposure step (b)(2/66-3/4). The irradiation step causes a color or textural change in the resist composition. This determinative radiation step corresponds to the applicant's imaging step. Use of fluorescent probes is taught at (5/54-6/45). Use of photosensitive acid generators is taught (10/49-11/32).

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Use of UV-light to cause the photo-acid generators to release acid is discussed at (10/58). Neckers discloses examples of the photohardenable resin used at (10/43-48). Crosslinking is discussed at (11/34-50) and elsewhere.

As written the claims do not require that the "subsequent exposure" is not part of the formation of the latent image pattern.

Nagashima et al. teaches that the use of print-out images is known in the prior art. A print-out image refers to the colored image formed in the photo-resist where exposure has occurred. The ability to provide a print-out image is very important because the inability to recognize exposed portions makes it difficult to perform subsequent exposures(1/13-37). The examiner takes this disclosure to indicate that the print-out image acts as a guide in determining the position of subsequent exposures.

Caruso teaches a photo-polymerizable composition comprising a leuco dye which upon photo-imaging converts to a colored form. The print-out image enhances the visibility of exposed areas(1/30-37).

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify the method taught by Neckers by using the formed latent image as a guide to determine the position for subsequent exposures of the resist based on the direction found in Nagashima et al. to the use of print-out images, which consist of colored portions corresponding to exposed portions of a photoresist, to provide guidance for further exposures.

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8. Claim 2 is rejected under 35 U.S.C. 103(a) as being unpatentable over Neckers 5,942,370 in view of Nagashima et al. 4,258,123 and Caruso 5,407,783 as applied above, further in view of Feke et al. 2002/0001768.

Neckers 5,942,370 in view of Nagashima et al. 4,258,123 and Caruso 5,407,783 as applied above teaches the use of **UV-light to generate acid** which then reacts with a pH sensitive dye to form a latent image. However, the reference does not teach an imaging step according to claim 2 wherein the imaging wavelength is different from that of the first or subsequent exposures.

Feke et al. teaches a method for measurement of profiles of photogenerated acid patterns in resists. In this example the acid sensitive dye is a pH dependent fluorescent dye that absorbs light and emits light at different wavelengths wherein the intensity of the emitted light is related to the pH of a particular environment(0022). Correspondingly, the acid is controlled through the exposure of the photo-acid generator(0003). Photo-acid generators are taught at (0023). Imaging using a microscope is disclosed at (0037-0038). **In this imaging step a wavelength of 450-490(visible light) is used.** Use of latent images is discussed at (0007). Use of base additives to precisely control acid concentration and to increase pattern sharpness is disclosed at (0006). For the method according to this invention see claims 1-6.

It would have been obvious to one of ordinary skill in the art to modify the method of Neckers 5,942,370 in view of Nagashima et al. 4,258,123 and Caruso 5,407,783 as applied above by forming photosensitive layer comprised of a polymeric resin, a photo-acid generator, and a pH-dependent fluorophore,

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exposing the resist to form the latent image by activating the photoacid generator using an **ultraviolet light source**, and imaging the resist using a wavelength of 450-490 nm(visible light) based on the disclosure of Feke et al. which teaches an imaging step used to image a resist containing a photo-acid generator and acid sensitive fluorescent dye. The imaging step of Feke et al. is done using a wavelength of between 450-490nm(visible light).

9. Claim 18-19 is rejected under 35 U.S.C. 103(a) as being unpatentable over Neckers 5,942,370 in view of Nagashima et al. 4,258,123 and Caruso 5,407,783 further in view of Feke et al. 2002/0001768 as applied above and further in view of Winkle 5,650,261.

Neckers 5,942,370 in view of Nagashima et al. 4,258,123 and Caruso 5,407,783 further in view of Feke et al. 2002/0001768 as applied above does not teach the limitations recited in claim 18. Feke et al. teaches the use of base additives to precisely control acid concentration and to increase pattern sharpness is disclosed at (0006), but does not teach that the resist also contains a photobase generator and that the wavelength at which the photobase generate generates base is different from the wavelength at which the photoacid generator generates acid. Neckers 5,942,370 in view of Nagashima et al. 4,258,123 and Caruso 5,407,783 further in view of Feke et al. 2002/0001768 as applied above also does not teach that the photosensitive material is a cross-linkable epoxy resin precursor.

Winkle teaches a photoresist composition containing an acid hardening resin system, an acid or acid generating compound, and a photobase generating

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compound(abstract). When the photoresist composition employs a photoacid generator the photoacid generator must be selected such that the exposing wavelength of light used to generate the acid does not cause the photobase generator in the photoresist composition to simultaneously produce a substantial amount of base(8/5-17). Two exposing steps are disclosed at (8/49-67). The examiner notes that the disclosure at (8/49-67) teaches that the base is generated before the acid. However, Feke teaches adding base after acid has already been released in order to precisely control acid concentration and increase pattern sharpness. Thus, Winkle is primarily being used for his teaching of a two step process in which a different wavelength of light from that used to generate the acid is used to generate base. Winkle teaches the use of an acid hardening resin wherein the resin system contains a polymer with crosslinking functionality including polymers having epoxy groups(7/7-27).

It would have been obvious to one of ordinary skill in the art to modify the photosensitive composition of Neckers 5,942,370 in view of Nagashima et al. 4,258,123 and Caruso 5,407,783 further in view of Feke et al. 2002/0001768 as applied above which contains a polymeric resin, a photo-acid generator, and a pH-dependent fluorophore, by adding a photobase generator which is sensitive to a wavelength of light different from that to which the photoacid generator is sensitive, based on the disclosure of Feke et al. to add base in order to precisely control acid concentration and increase pattern sharpness and based on the disclosure of Winkle et al., and with the reasonable expectation of having increased control over the acid concentration in the photosensitive layer. Further,

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it would have been obvious to use a polymeric resin, for example a polymer with crosslinking functionality including polymers having epoxy groups which contains an acid catalyzed self cross linking, in the photosensitive composition above which also contains a photoacid generator, based on the disclosure in Winkle at (7/7-27).

10. Claims 6-10 are rejected under 35 U.S.C. 103(a) as being unpatentable over Neckers 5,942,370 in view of Nagashima et al. 4,258,123 and Caruso 5,407,783 as applied above and further in view of Tuberfield et al. 6,358,653.

Neckers 5,942,370 in view of Nagashima et al. 4,258,123 and Caruso 5,407,783 as applied above does not teach the limitations recited in claims 6-10.

Claim 1 of Tuberfield et al. recites a method for forming a photonic crystal material comprising irradiating a sample of photosensitive material with electromagnetic radiation propagating in different directions within the sample to generate a three dimensional periodic variation of the intensity of irradiation within the sample by interference between the electromagnetic radiation propagating in the different directions selectively controlling the relative intensity of the electromagnetic radiation propagating in different directions, selectively controlling the polarization of the electromagnetic radiation propagating in different directions and developing the irradiated sample of the photosensitive material to remove regions of the sample in dependency upon their irradiation said regions forming a connected network to produce a structure having three dimensional periodic(repeating in regular intervals) variation in refractive index based on the periodic(repeating in regular intervals) variation of the intensity of

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irradiation. Claim 5 recites a method as claimed in claim 1 further comprising **repeating the steps of irradiating** the sample with electromagnetic radiation of controlled intensity and polarization thereby to subject the sample to **multiple exposures** each exposure producing respective interference patterns with the sample. A three dimensional structure can be obtained by use of at least four intersecting beams(3/45-47). Formation of defects within the photonic crystal material for the purpose of creating waveguides or microcavities(7/59-67).

It would have been obvious to one of ordinary skill in the art at the time of the invention to modify the method taught by Neckers by forming a pattern of light which regularly repeats in two or three dimensions such as to define in the photosensitive material regions of the photosensitive material for forming a photonic crystal lattice as taught by Tuberfield in claim 1 and using the formed latent image as a guide to determine the position for subsequent exposures of the resist based on the direction found in Nagashima et al. to the use of print-out images, which consist of colored portions corresponding to exposed portions of a photoresist, to provide guidance for further exposures. Further it would have been obvious to have the further exposure be used to define a modification in the photonic crystal lattice where in the modification is a discontinuity for defining a structure operable as a waveguide as disclosed by Tuberfield et al. with the reasonable expectation that the latent image formed by the first exposure will provide guidance for multiple exposures resulting in a decrease in the difficulty involved in performing subsequent exposures.

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11. Claims 11-14 are rejected under 35 U.S.C. 103(a) as being unpatentable over Neckers 5,942,370 in view of Nagashima et al. 4,258,123 and Caruso 5,407,783 and further in view of further in view of Feke et al. 2002/0001768 as applied above, and further in view of Pavel WO 00/31733.

Neckers. et al. teaches a latent image forming step, an imaging step, and subsequent exposure using the latent image as a guide. As noted the applicant's claims do not exclude the possibility that the "subsequent exposure" is part of the formation of the latent image pattern. Neckers also has disclosure of the use of fluorescent probes as part of the photosensitive material. Nagashima and Caruso disclose the benefits of print-out images including that they provide guidance for further exposures. Feke et al. teaches exposure and imaging of photosensitive materials comprising pH dependent fluorescent dyes, and photo acid generators. Feke's disclosure includes the use of a microscope for imaging.

The combination of Neckers 5,942,370 in view of Nagashima et al. 4,258,123 and Caruso 5,407,783 and further in view of further in view of Feke et al. 2002/0001768 does not teach the limitations recited in claims 11-14.

Pavel et al. reading and writing in an optical recording medium having a fluorescent photosensitive material. Pavel teaches that a confocal microscope is preferably used due to the fact that it improves depth resolution and allows a user to obtain a precise depth selection in a three-dimensional structure. A confocal microscope provides a high-precision volume selection tool that prevents spherical aberrations(page 8 lines 26-34). Reading of a recording medium containing a fluorescent photosensitive material is described at (page 12

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line 30- page 13 line 21). Reading is based on a difference in fluorescence between one area and another. Reading achieves the same result as the imaging step of Feke et al. 2002/0001768, but this reading step is done using a confocal microscope as opposed to the microscope disclosed by Feke et al. Two photon processes are disclosed at (page 10 line 1- page 11 line 19). Writing using a two-beam process and a confocal microscope is taught at (page 23 line 3-18).

It is noted that the photosensitive materials disclosed by Pavel are different than those taught by the applicant and include glass and vitroceraamics. However, the teachings of Pavel still apply to fluorescent photosensitive materials in general.

It would have been obvious to one of ordinary skill in the art to modify the process taught by Neckers et al. in view of Nagashima et al. 4,258,123 and Caruso 5,407,783 and further in view of further in view of Feke et al. 2002/0001768 by forming a latent image in a photosensitive material containing a pH dependent fluorescent dye and a photo acid generator, imaging(reading) the latent image using a confocal microscope to determine the position of the exposure, based on the example of Feke et al. to use a microscope for the imaging step and the disclosure of the benefits of the confocal microscope by Pavel, and to further to perform a subsequent exposure using the latent image as a guide. Further, it would have been obvious to have the subsequent exposure include a two-photon writing step using a confocal microscope wherein the fluorescent intensity in the subsequently exposed areas will be greater than

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those only exposed once, based on the general disclosure of "subsequent exposures" by Neckers et al. and based on the teachings of Pavel and with the reasonable expectation that the pattern formed using the confocal microscope will exhibit improved depth resolution as taught by Pavel.

Conclusion

12. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Anna L. Verderame whose telephone number is (571)272-6420. The examiner can normally be reached on M-F 8A-4:30P.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Mark Huff can be reached on (571)272-1385. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

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